

CHAPTER 22

STATIC UNINTERRUPTIBLE POWER SUPPLY

22-1. Minimum maintenance activities for static uninterruptible power supply

The tables located at the end of this chapter indicate items that must be performed to maintain systems and equipment at a minimum level of operational readiness. The listed minimum action items should be supplemented by manufacturer-recommended maintenance activities and procedures for specific pieces of equipment. Maintenance actions included in this chapter for various modes of operation, subsystems, or components are summarized in table 22-1.

22-2. General maintenance procedures for static uninterruptible power supplies

Inspection frequencies may be increased as required based on observation and experience.

a. Review maintenance records. Review past maintenance records to find repair patterns indicating certain components to inspect during performance of preventive maintenance.

b. Review operator records. Review operator records concerning electrical load connected to the uninterruptible power supply (UPS) and compare with equipment ratings. Review operator records concerning number of transfers and their causes.

c. Inspect UPS module. Perform a general inspection of the UPS equipment as described below.

- (1) Inspect to ensure that warning signs exist.
- (2) Inspect equipment enclosures for damage, unauthorized openings, and corrosion of metallic objects.
- (3) Inspect equipment grounding components such as conductors and connections.
- (4) Inspect electrical connections for degradation.
- (5) Inspect insulation for discoloration and degradation.
- (6) Inspect equipment's internal air passages and remove any blockage.
- (7) Inspect, investigate, and solve conditions for unusual odors.
- (8) Inspect, investigate, and solve conditions for unusual noises.
- (9) Inspect locking devices.

d. Inspect battery. UPS battery systems shall be inspected as described below.

- (1) Perform visual checks of the following.

(a) Jar seals

(b) Terminal condition

(c) Battery plate discoloration - Discoloration can indicate battery problems.

(d) Sediment - Sedimentation is not a problem unless it reaches the plates in the cell and creates a short circuit. Rapid buildup indicates a problem cell or incorrect operation. Plates normally wear out before the sediment space is filled.

(e) Mossing - Mossing is the buildup of sulfates on battery plate surfaces. Excessive mossing can interfere with charging and discharging. Rapid buildup of moss indicates a problem cell.

(f) Gassing - Bubbles will form in the electrolyte of cells being charged. If bubbles do not form the cell has serious problems.

(g) Electrolyte level

(h) Vents

(i) Flame arresters

(2) Inspect batteries for leaks.

(3) Inspect battery rack for corrosion.

(4) Inspect battery rack for loose components.

(5) Verify that battery rack is grounded.

(6) Record battery bank charge voltage and the type of charge, be it float or equalization.

(7) Record battery charging current. Compare readings to previous readings.

(8) Measure specific gravity of electrolyte in pilot cell and correct for temperature.

(9) Inspect battery charger for abnormalities.

e. Inspect UPS ventilation filters. Clean or replace air filters as required.

f. Tighten electrical connections. Tighten each electrical connection, including battery intercell connectors, to the proper torque value.

g. Clean equipment. Thoroughly clean all components and areas of the UPS modules and batteries.

h. Calibrate metering. Using calibrated test equipment, calibrate all meters.

i. Test switches. Using a volt-ohmmeter, verify correct operation of all switches.

j. Test control cabinet. Test indicating lamps and replace as required. Test annunciator's local visual and audible alarm.

k. Perform battery cell tests. Battery cell testing shall be performed as described below.

(1) Measure specific gravity of each cell's electrolyte and correct for temperature. Compare with past readings.

(2) Record the voltage of each cell. Evaluate and compare with past readings.

(3) Record a sampling of intercell connector resistances. Resistance should typically be very low, on the order of 0.01 ohm.

l. Test phase bus insulation. Perform insulation resistance test on each phase-to-phase and phase-to-ground using a megohmmeter.

m. Perform infrared test. Test all main current carrying conductors for hot spots indicating overload or loose connections. This test should be simultaneous with the load test.

n. Perform harmonic analysis. An analysis to determine the presence of harmonics should be performed. This analysis may first be performed with an oscilloscope to determine the extent of harmonics. Should further evaluation be required, a harmonic distortion analyzer should be utilized.

o. Run diagnostics. If system is so equipped, run the internal system diagnostics to identify items needing correcting.

p. Verify alarm set points and control limits. Correct operation of alarms and controls shall be verified as described below.

(1) Calibrate alarm set points such as temperature alarms, overvoltage alarms, overcurrent alarms, etc.

(2) Calibrate control limits for static switch operation, cooling fan operation, cooling water control, oscillator, load sharing controls, etc.

(3) Verify correct action of any associated remote alarm.

q. Perform load test. This test may be eliminated if during the past six months the UPS operated on battery and successfully discharged close to the minimum battery voltage. Performing the above test in this case would shorten the life of the battery and would offset any gain from the test.

(1) A complete load test in accordance with Institute of Electrical and Electronic Engineers (IEEE) 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Application, will prove the battery system. This procedure should include opening the UPS input (normal power) circuit breaker and supplying actual load from the batteries. Battery bank voltage and discharge times should be recorded. Testing should stop when either the maximum operational design time is reached or when the battery voltage reaches the designed minimum.

(2) As an alternate load test, the building load should be placed on maintenance bypass and load banks connected to the UPS. The load banks may be unity power factor or simulate design load including

power factor. The batteries would then supply the test load. Testing should be stopped when the battery voltage reaches the designed minimum.

r. Measure and record neutral currents. Using a true rms ammeter, measure neutral currents with site load. If amperage is abnormal, investigate for load imbalances and harmonics.

Table 22-1. Static uninterruptible power supply

Static Uninterruptible Power Supply	
<i>Action</i>	<i>Frequency</i>
<p style="text-align: center;">WARNING!</p> <p style="text-align: center;">MAINTENANCE PERSONNEL SHALL LOCKOUT/TAG EQUIPMENT TO ENSURE DE-ENERGIZATION DURING MAINTENANCE PROCEDURES.</p>	
Review maintenance records.	mo
Review operators records.	mo
Inspect UPS module for the following:	
Inspect equipment enclosures for damage, unauthorized openings, and corrosion of metallic objects.	yr
Inspect equipment grounding components such as conductors and connections.	yr
Inspect electrical connections for degradation.	yr
Inspect insulation for discoloration and degradation.	yr
Inspect equipment's internal air passages and remove any blockage.	yr
Inspect, investigate, and solve conditions for unusual odors.	yr
Inspect, investigate, and solve conditions for unusual noises.	yr
Inspect locking devices.	yr
Inspect UPS battery systems for the following:	
Perform visual checks of the following on batteries:	
Jar seals.	mo
Terminal condition.	mo
Battery plate discoloration.	mo
Sediment.	mo
Mossing.	mo
Gassing.	mo
Electrolyte level.	mo
Vents.	mo
Flame arresters.	mo
Inspect batteries for leaks.	mo
Inspect battery rack for corrosion.	mo

Table 22-1. Static uninterruptible power supply (continued)

Static Uninterruptible Power Supply	
<i>Action</i>	<i>Frequency</i>
Inspect battery rack for loose components.	mo
Verify that battery rack is grounded.	mo
Record battery bank charge voltage and the type of charge.	mo
Record battery charging current. Compare readings to previous readings.	mo
Measure specific gravity of electrolyte in pilot cell and correct for temperature.	mo
Inspect battery charger for abnormalities.	mo
Inspect UPS ventilation filters (Most UPS modules have air filters as part of the internal forced air cooling fans. The need to change or clean them will vary with the existing environmental conditions.)	mo
Tighten electrical connections	yr
Clean equipment	yr
Calibrate metering	mo
Using a volt-ohmmeter, verify correct operation of all switches.	mo
Test control cabinet	
Test indicating lamps and replace as required.	mo
Test annunciator's local visual and audible alarm.	mo
Perform battery cell tests	
Measure specific gravity of each cell's electrolyte and correct for correct temperature. Compare with past readings.	3 mos
Record the voltage of each cell. Evaluate and compare with past readings.	3 mos
Record a sampling of intercell connector resistances.	3 mos
Test phase bus insulation	yr
Perform infrared test	yr
Perform harmonic analysis	yr
Run diagnostics	mo
Verify alarm set points and control limits	
Calibrate alarm set points such as temperature alarms, overvoltage alarms, overcurrent alarms, etc.	yr
Calibrate control limits for static switch operation, cooling fan operation, cooling water control, oscillator, load sharing controls, etc.	yr

Table 22-1. Static uninterruptible power supply (continued)

Static Uninterruptible Power Supply	
<i>Action</i>	<i>Frequency</i>
Verify correct action of any associated remote alarm.	yr
Perform a complete load test in accordance with IEEE 450.	3 mos
Measure and record neutral currents	yr